Response to Reviews for the Manuscript "The Boundary Layer Dispersion and Footprint Model: A fast numerical solver of the Eulerian steady-state advection-diffusion equation"

Response to Reviewer #3

We sincerely appreciate the referee's thorough review of our manuscript and the valuable comments and suggestions provided. The feedback has been instrumental in improving the quality of our research. We have carefully considered each of the remarks and made comprehensive revisions to the manuscript. Below, we provide a detailed point-by-point response to all comments, citing the reviewer statements in black font, while our answers are given in blue font.

Suggestions for revision

Generally, the rationale and model are well described. For the more general audience of GMD (as opposed to a dedicated meteorology journal), I wonder if some of the more technical parts could be explained in more accessible language. For example, "turbulence closure scheme" is well understood by (micro/)meteorologists, but not much beyond that.

A few words explaining turbulence closure were added in the revision.

A few sentences explaining the model and the logic of the decisions made in plainer English might help. A graphic to help visualise the model might help the general reader.

We thank the referee for this comment. In the revised version of the manuscript, we added a flow chart in Figure 1 visualizing BLDFM's framework. It also contains references to the individual sections and therefore serves as a guide for the general reader through the manuscript.

Comparison with some other footprint models would be useful. In my own field, the model of Kljun et al. [2015] is seen as an improvement over KM01 model. Some comparison against that would be of interest. More generally, some discussion of which models/approximations are suited to which purposes might be worth adding.

The footprint model of Kljun et al. [2015] is conceptually very different from BLDFM. For example, it needs the boundary layer height as an input parameter, which is not needed for BLDFM. Therefore, we opted for the well-established and widely used model of Kormann and Meixner [2001] for a better comparison.

All comparison is made against other models, none with observational data. I understand this is difficult, but worth some consideration, if only to explain why it is not done.

We agree that this sort of assessment would be very interesting. We believe that a real-data comparison goes beyond the scope of this paper. However, a study with data from tracer release experiments is planned for the future, as mentioned in the conclusion section. Here, we also plan to include the Kljun model for comparison.

The model is labelled as both a Dispersion and Footprint model, but no examples of its use to model dispersion are given. This seems worth adding. Dispersion might be a more tractable case for model validation also.

Figure 2 shows concentration and flux fields from a dispersion experiment with a point source. We improved the text to state unambiguously that the result pertains to a dispersion experiment.

Specific points

1. Fig 2 & 3: The purpose of the orange line is not clear to me. Is it on the same y axis?

   We thank the referee for this comment. The orange line is a third-degree monomial representing third-order error convergence as an upper bound for the theoretical error. The actual error drops exponentially with increasing resolution, i.e., by decreasing the effective grid size. This was added in the caption of Fig 2 and 3.

2. l239 & Fig 2 & 3: "effective grid size" is a misleading term - they do not mean the size of the domain (grid), they mean the resolution of the grid. Correct the wording and add some explanation of what h means in the caption - Figures should make sense on their own.

   The caption was revised accordingly, emphasizing that a decrease in effective grid size corresponds to an increase in resolution.

3. l254: "diametrical paradigm" should be "diametrical opposite paradigm" (if they mean "very different").

   Thanks for spotting this inaccuracy. We changed this as suggested in the revised manuscript.

4. l269. The term "receptor" is introduced. Previously this was referred to as the "measurement point" - use the same term if the same meaning is intended.

   We are grateful for pointing out this inconsistency. To make matters clear, we added the term "receptor" accompanying the term "measurement point" to the paragraph in question.

References

N. Kljun, P. Calanca, M. W. Rotach, and H. P. Schmid. A simple two-dimensional parameterisation for Flux Footprint Prediction (FFP). *Geoscientific Model Development*, 8(11):3695–3713, Nov. 2015. ISSN 1991-959X. doi: 10.5194/gmd-8-3695-2015.

R. Kormann and F. X. Meixner. An Analytical Footprint Model For Non-Neutral Stratification. *Boundary-Layer Meteorology*, 99(2):207–224, May 2001. ISSN 1573-1472. doi: 10.1023/A:1018991015119.